Preliminary study of Electron reconstruction In LArIAT

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What? Why?

- *"Borrow" from Microboone the latest reconstruction tools and test them on electrons simulated in the LArIAT geometry.*

- *Check the performance of these reconstruction tools on e-m showers in the energy range of interest for LArIAT (100 MeV – 1 GeV): find out what's already in place, what needs to be done, whether or not we have to implement different approaches for low energy VS high energy e-m showers...*

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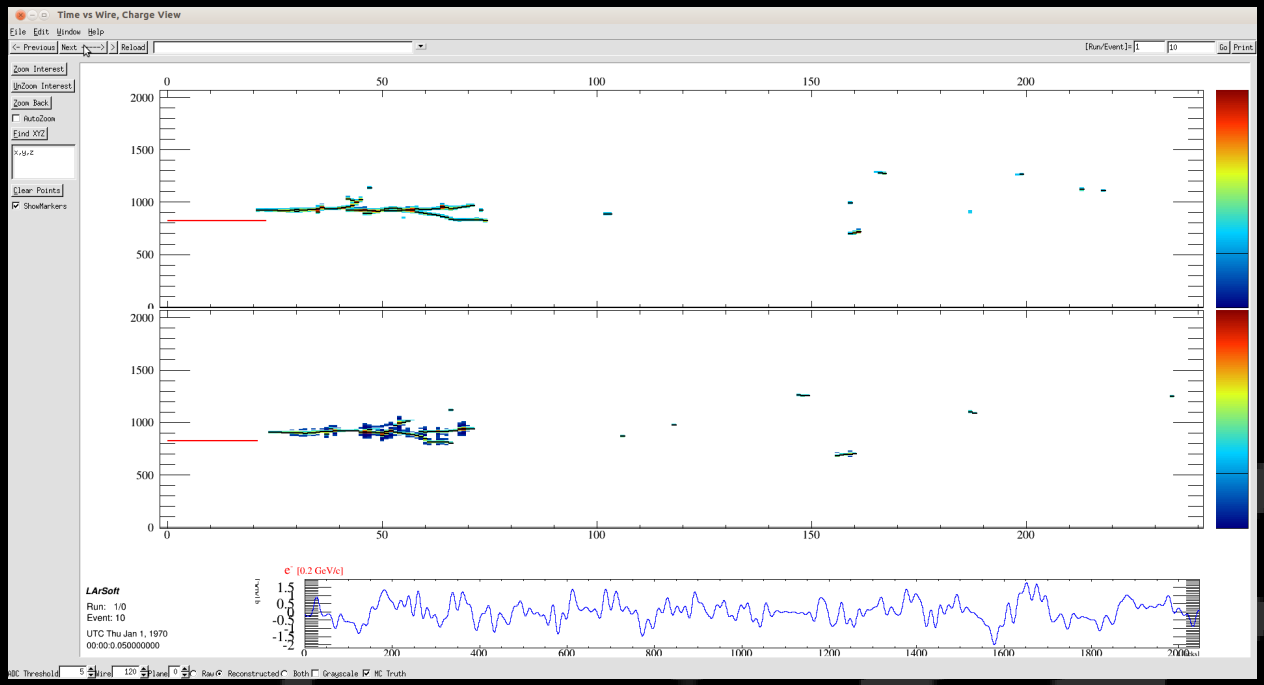
PRELIMINARY STUDY/RESULTS!!!!

How?

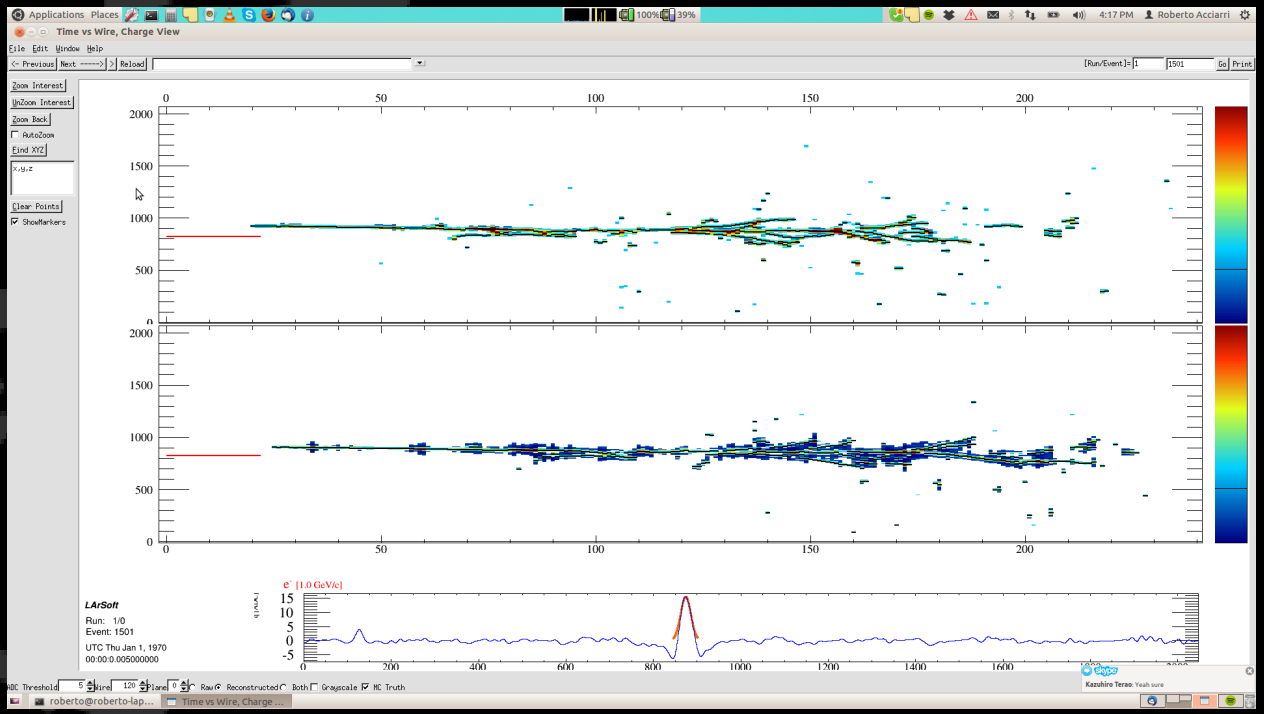
- *Four energies considered: 0.25±0.15 GeV, 0.50±0.15 GeV, 0.75±0.15 GeV, 1.00±0.15 GeV.*
- *For each energy, 300 electrons starting OUTSIDE the cryostat have been simulated.*
- *The simulation has been done twice: with and without the presence of a ~1 X_0 pre-shower disk.*

In total, 1200 electrons with energies ranging from 0 to ~1.4 GeV have been simulated both with and without the presence of a pre-shower disk.

Ben Carls Fuzzy Cluster has been applied to the simulated events and plots of # clusters VS initial energy, energy deposited/lost VS initial energy produced…

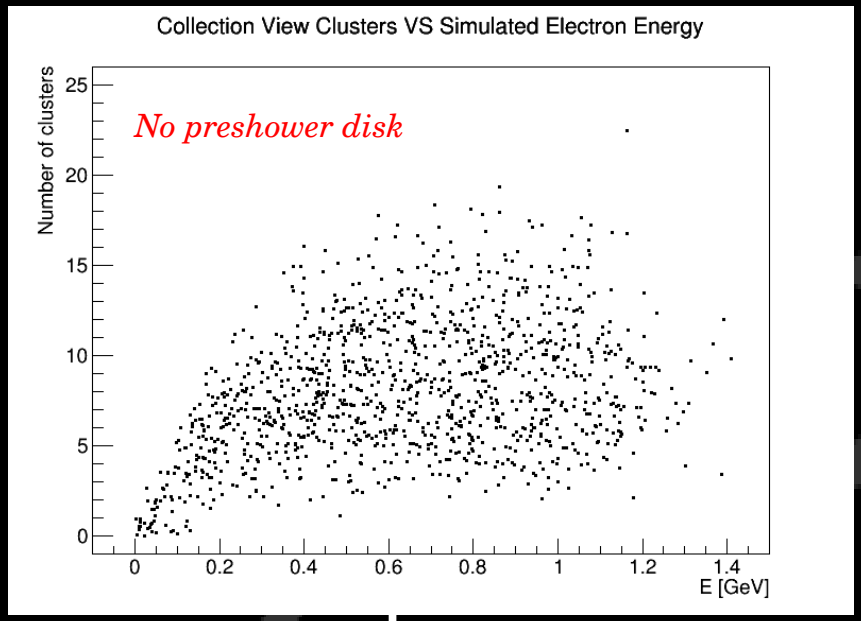


200 MeV electron



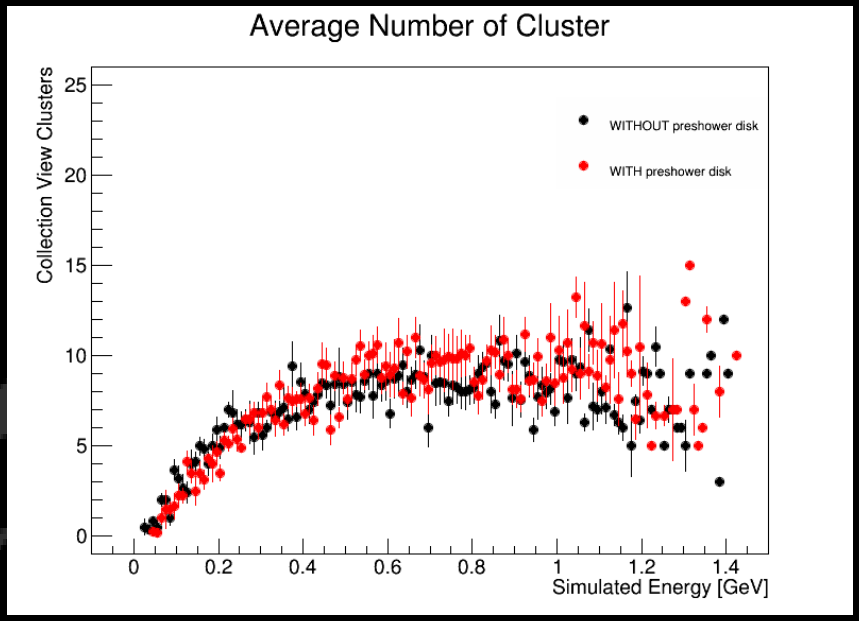
1 GeV electron

Number of Cluster VS Simulated Electron Energy

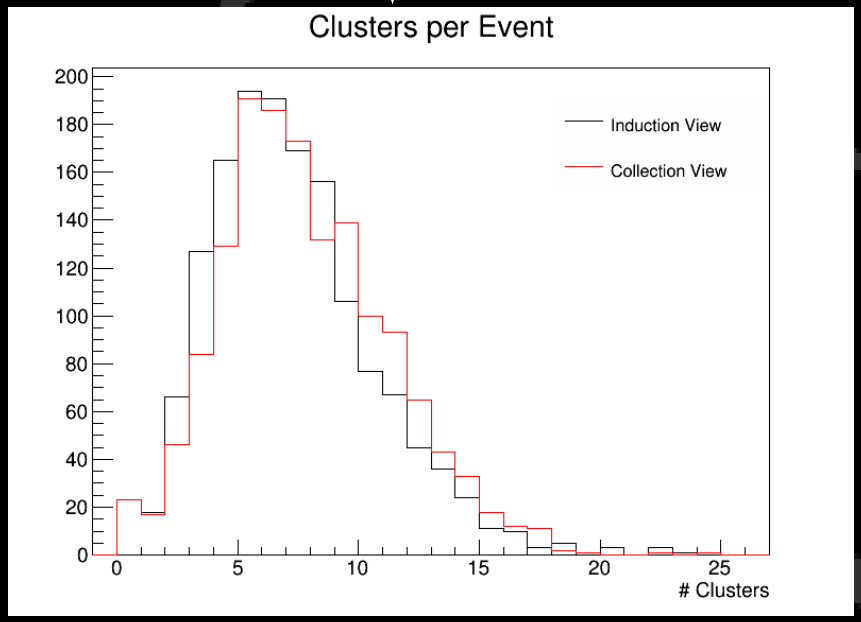


Profile

Histogram



Projection onto Y axis



Both in induction and collection view, both with and without preshower disk, the e-m shower generated by an electron is broken into several small clusters (on average, about 8 clusters).

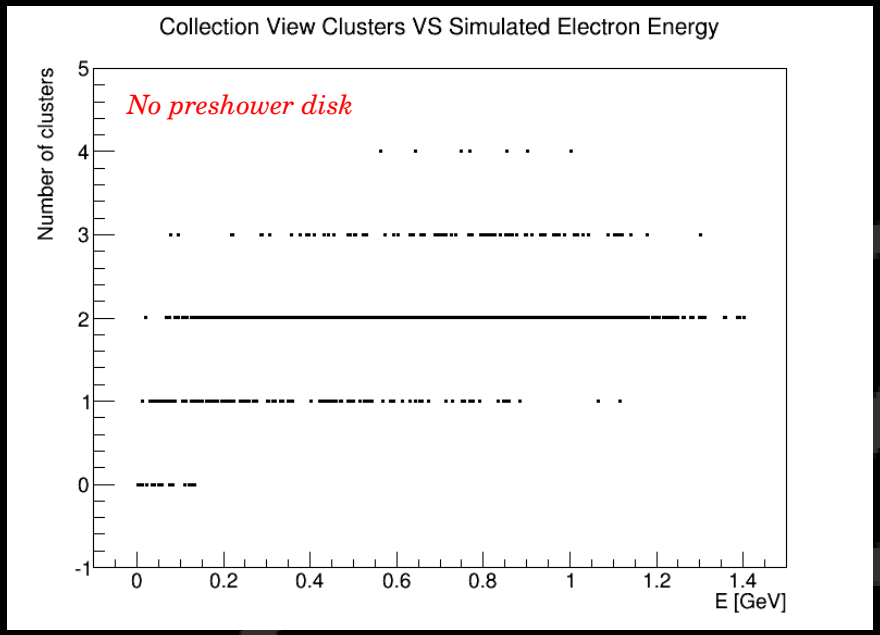
Energy reconstruction from such clusters would be really hard and affected by a large uncertainty.

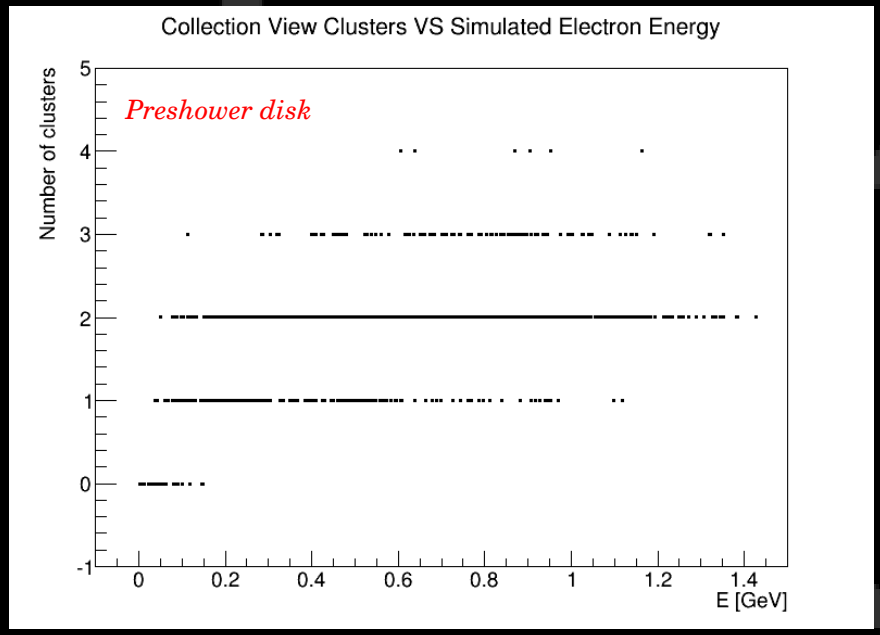
Some remarks...

✔ *This clustering algorithm is developed for Microboone, with the idea to reconstruct multiple particles present in nu interactions (as opposite from LArIAt, where we expect ~ 1 particle at a time in the detector).*

✔ *This study aims at investigate whether we can tune the parameters of the existing Microboone algorithms to make them suitable to LArIAT, or whether we need to develop our own for LArIAT's case of single particle tracking.*

Solution #1: Fuzzy Cluster tweak

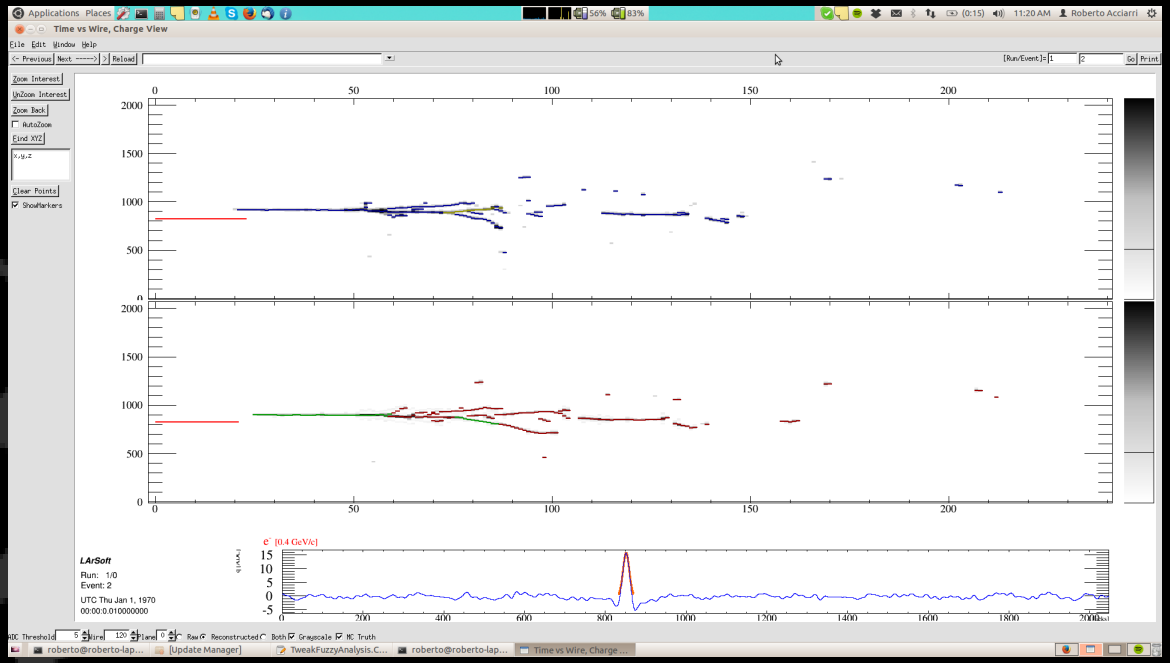


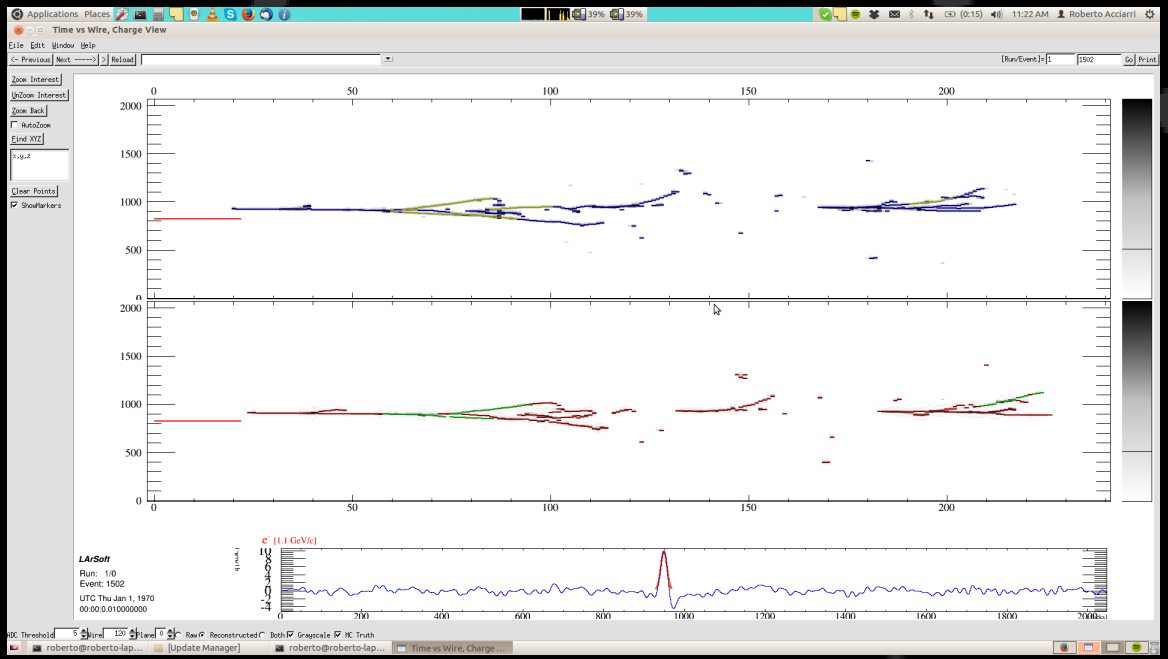


- ✔ *Change Fuzzy Cluster parameters (max clustering angle, distance between clusters..) to merge everything in one single cluster.*
- ✔ *Quite an improvement, but not there yet. Especially because the clustering becomes "random" (see next slide).*
- ✔ *Speaking about with Ben C: "Fuzzy cluster is made to break up things. DB Cluster would work better in your case" (cit).*

Solution #1: Fuzzy Cluster tweak

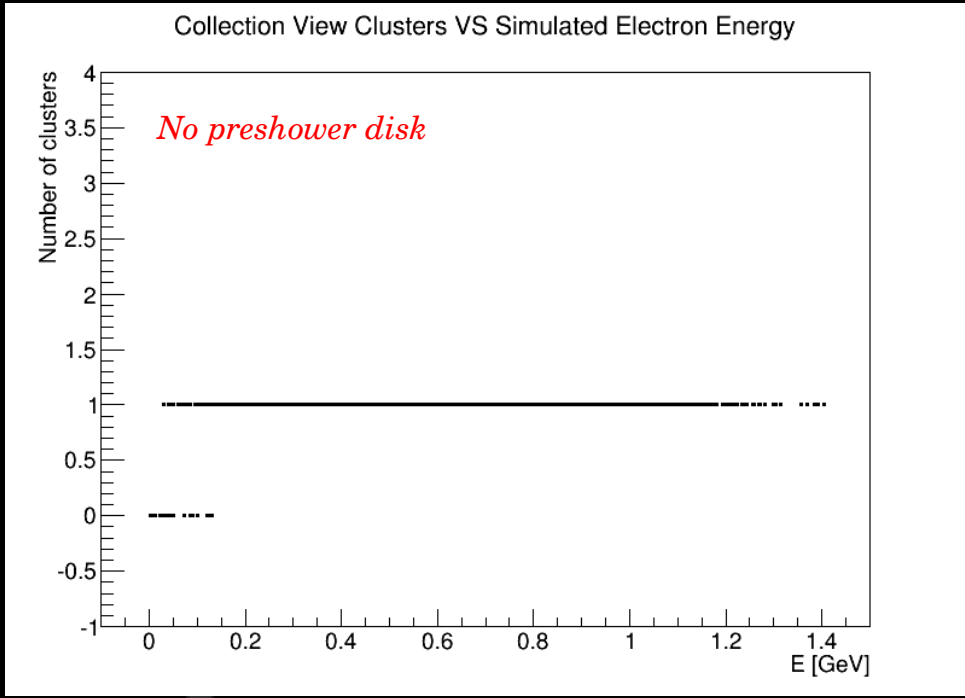
400 MeV electron





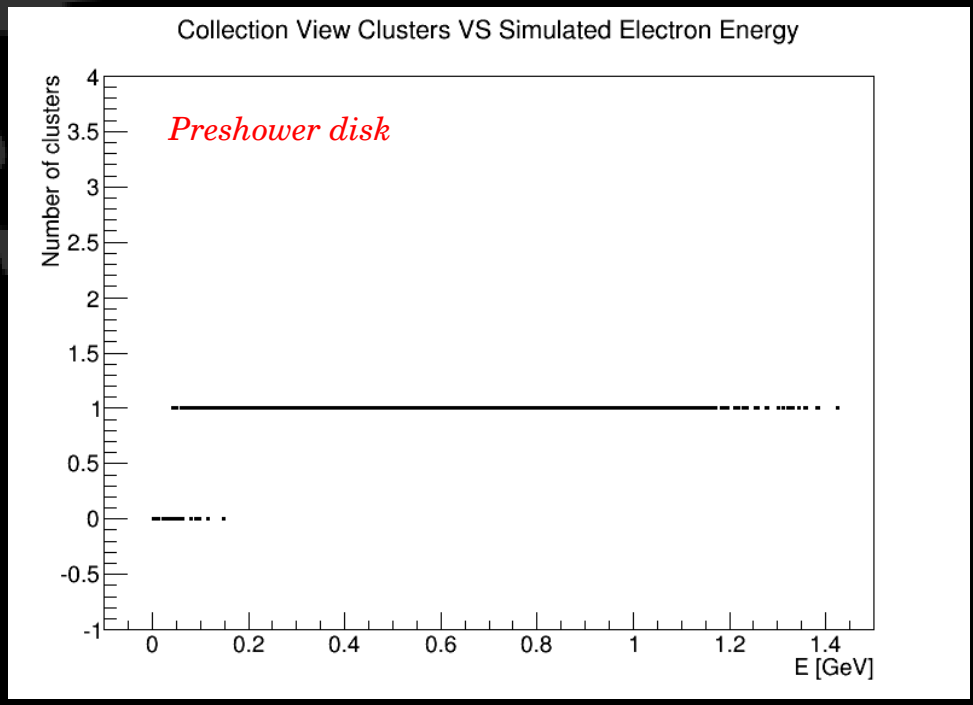
1.1 GeV electron

Solution #2: DB Cluster tweak



- ✔ *Change DB Cluster parameters to merge everything in one single cluster.*
- ✔ *Works! No need to create a specific LArIAT clustering algorithm.*

To be honest, the next step in the chain - shower reconstruction - can indeed make the job of merging all the clusters in the view. I anyway prefer to switch to DB Cluster and deal with just one cluster from the beginning.



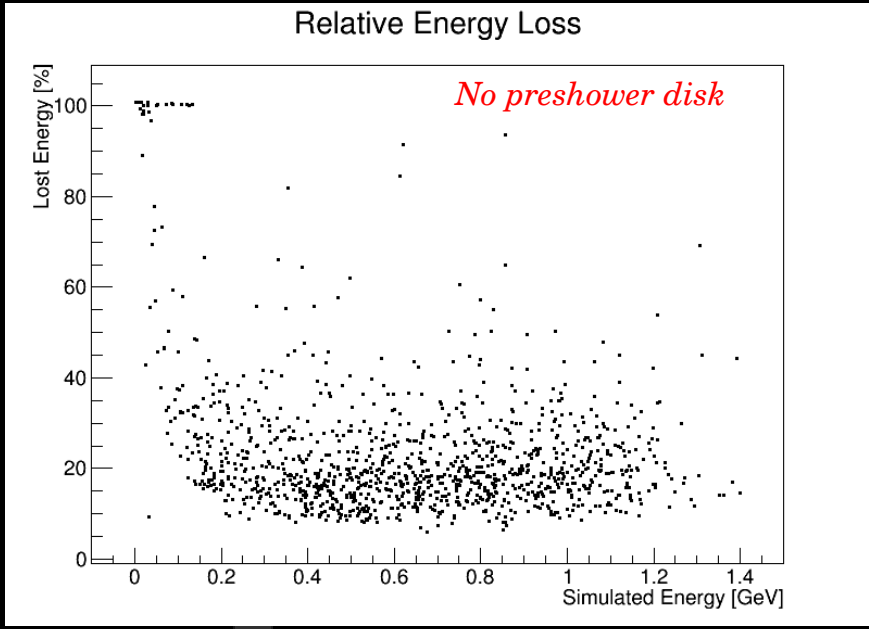
From clustering to energy containment

- ✔ *Once found a clustering algorithm suitable for LArIAT electron events, we need to test its performance.*

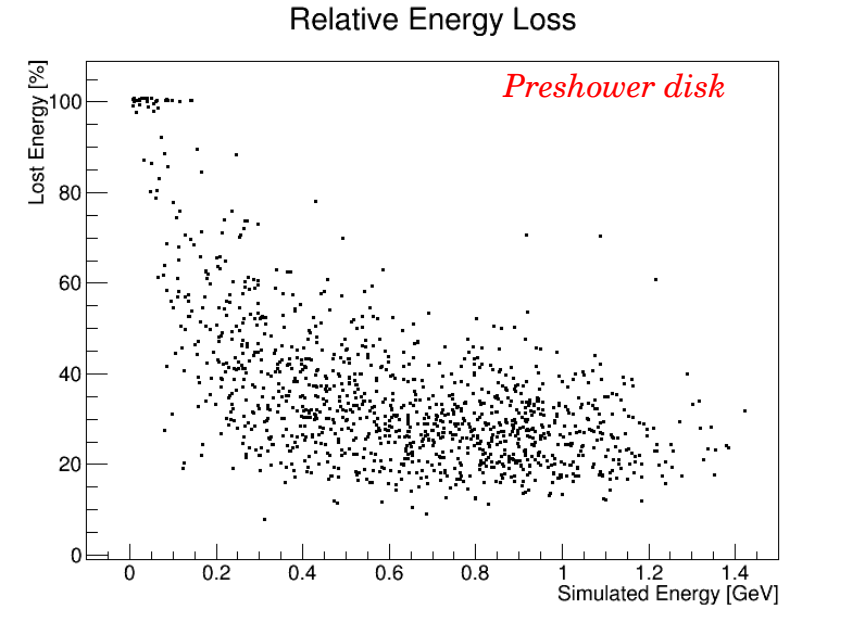
- ✔ *That is, determine what fraction of the electron energy deposited in the TPC is successfully reconstructed.*

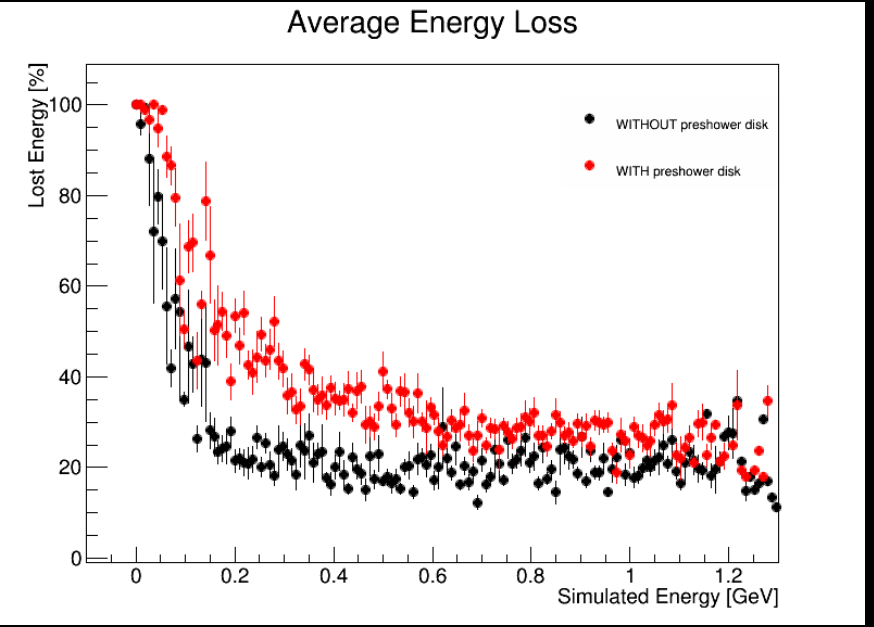
- ✔ *To be able to do this, we first need to know how much of the electron shower energy (MC Truth) is contained in the TPC, as a function of the electron initial energy.*

Energy Lost VS Simulated Electron Energy



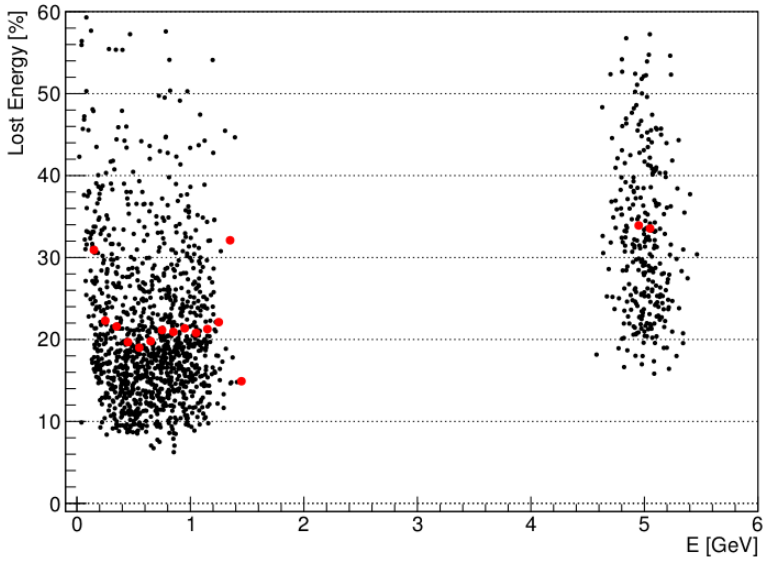
- ✔ *Energy lost both upstream and downstream the TPC.*
- ✔ *Bunch of events at 100% E Loss gives an indication of the energy lost before entering the TPC.*
- ✔ *Flat part for E>0.5 GeV suggests events may be mostly contained.*



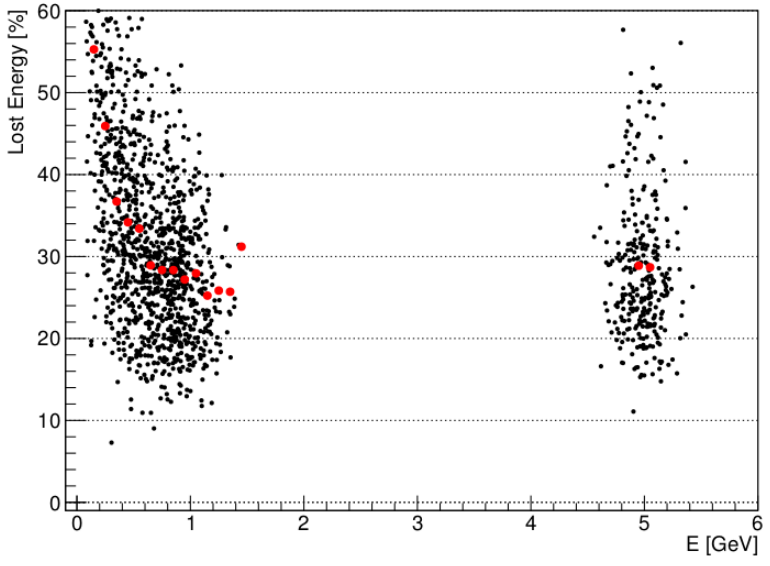


Energy Lost VS Simulated Electron Energy

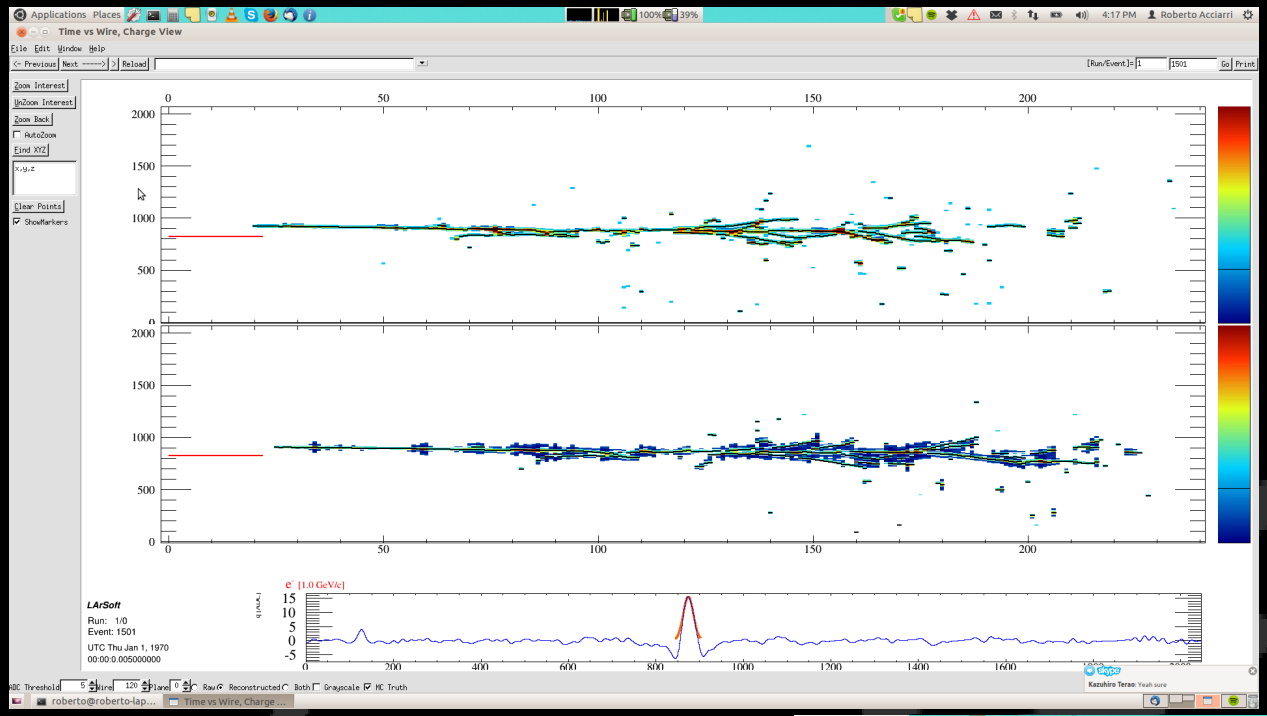
No preshower disk



Preshower disk

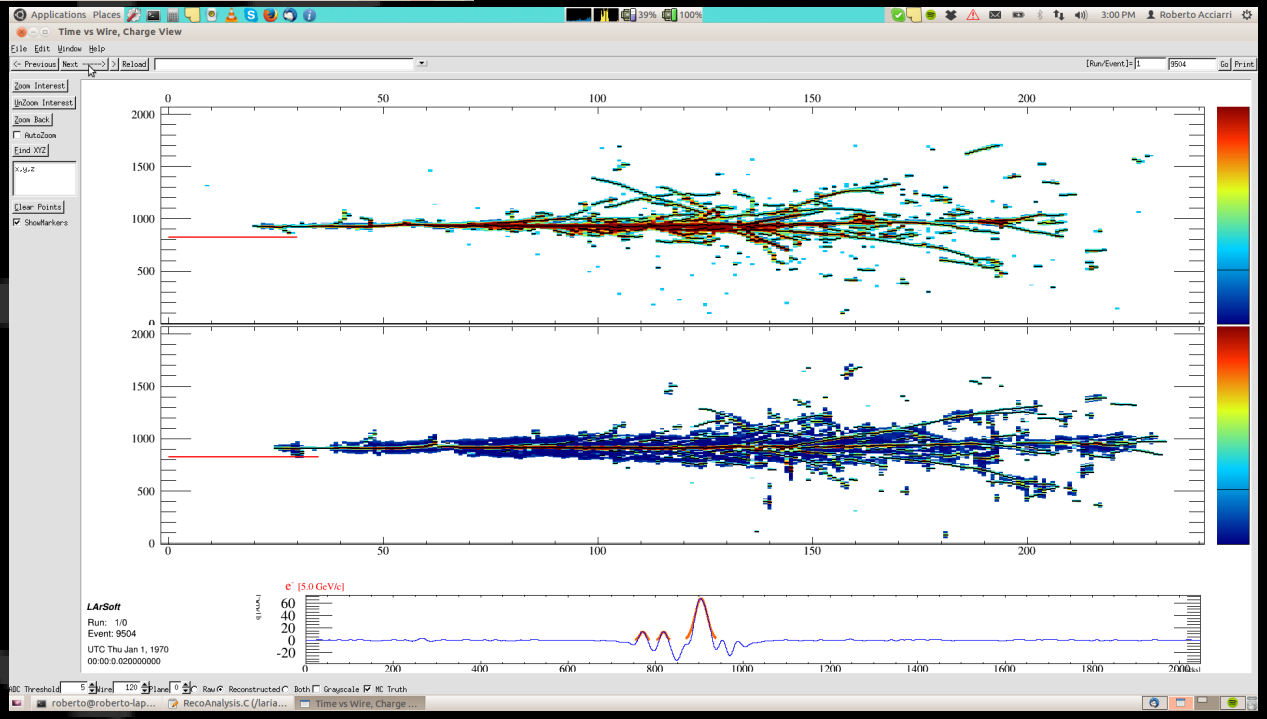


- ✔ *300 5 GeV electron events have been simulated both with and without preshower disk.*
- ✔ *Check whether the flat trend on the energy loss is due to particle containment or to a bug in the analysis code.*
- ✔ *Average energy loss for 5 GeV events higher than for 1 GeV. We can therefore assume we have some degree of containment for 1 GeV electrons.*



1 GeV electron

5 GeV electron



Conclusions / What's next

- *Identified a clustering algorithm suitable for energy reconstruction.*
- *Determined the fraction of electron shower contained in LArIAT, as a function of electron energy.*
- *Some indication the minimum energy lost by electrons before entering the TPC is of the order of 50-100 MeV.*
- *Some indication that 1 GeV electrons may be contained in a consistent fraction of the cases.*

Next step:

- *Look at the reconstructed energy VS MC true contained energy to define the performance of the clustering algorithm.*
- *Define whether or not different algorithms are needed at different energies.*